Carnegie Mellon
Software Engineering Institute

Why Do Organizations Have Assessments? Do They Pay Off?

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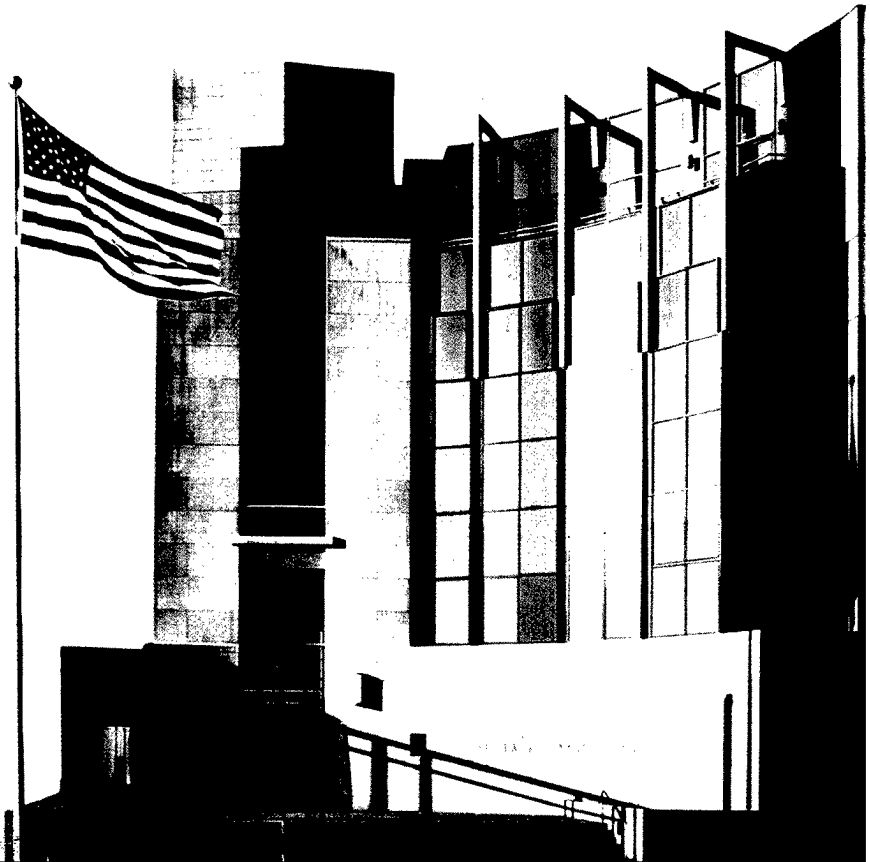
July 1999



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Software Engineering Process Management (SEPM) Program

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Acknowledgments

The SEI would like to acknowledge panelists at previous Software Engineering Process Group (SEPG) conferences who generously shared their experiences and presented to the community the results achieved by the users of the Capability Maturity Model® (CMM®)-Based Appraisal for Internal Process Improvement (CBA IPI) method.

E-SEPG 1999:	Marilyn Bush	Consultant
	Annie Combelles	Objectif Technologie
	Gilles des Rochettes	Thomson-CSF
	Paul Iredale	Reuters
	Guy Taylor	US Navy
SEPG 1999:	(Authors of this report)	
SEPG 1998:	Eduardo Frias	Andersen Consulting
	Andy Felschow	Software Productivity Consortium
	Judah Mogilensky	Process Enhancement Partners, Inc.
	Jennifer Simmons	Theta Information Systems, Inc.
SEPG 1997:	Richard Basque	ASEC
	Mary Busby	Lockheed Martin
	John T. Harding	Software Technology Transition
	Mary Sakry	The Process Group
	Cynthia Torpey	ChangeBridge, Inc.
	John Vu	Boeing Company
	Dick Waina	Electronic Data Systems
SEPG 1996:	Larry Bramble	Allied Signal
	Susanne Kelly	Citibank NA
	John Pellegrin	Motorola
	John Vu	Boeing Company
E-SEPG 1996:	Susanne Kelly	Citibank NA
	John Vu	Boeing Company

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Abstract

The authors of this report appeared on a panel at SEPG '99 (1999 Software Engineering Process Group Conference) on March 10, 1999, in Atlanta, Georgia. Each panelist is one of the "most active lead assessors" in the Software Engineering Institute (SEI) Appraiser Program and has conducted and reported on over 5 Capability Maturity Model® (CMM®) -Based Appraisals for Internal Process Improvement (CBA IPIs) over the past 18 months. In this report, the panelists document their experiences regarding why an organization chooses to have a CBA IPI and what the organization gains from having conducted an assessment.

Each author discusses the experiences related to CBA IPIs that he or she has led with a focus on the organizational perspective before, during, and after the assessment. Since a CBA IPI is a major organizational intervention, it is important to know why an organization has an assessment, if it has a positive impact on an organization, and how an organization would characterize the benefits that the assessment provides. What needs to be done during the planning, how the assessment is conducted, and what follows the assessment are all important factors that will affect the benefits that the organization experiences from the assessment.

1 Background

1.1 History of SEI Assessments

In early software process publications, a software maturity framework and questionnaire [Humphrey 87a] were developed to help organizations characterize the current state of their software practices and to help the U.S. Government assess the ability of potential Department of Defense (DoD) contractors to develop software through Software Capability Evaluations (SCEs[SM]) [Humphrey 87b]. The Software Engineering Institute (SEI) assisted a number of organizations in performing assessments [Olson 89] based largely on the Maturity Questionnaire. In 1988-91, the SEI provided training to organizations that wished to perform self-assessments of their software processes.

In 1990 the SEI commercialized the Software Process Assessment (SPA) to disseminate the technology more broadly. Industry and government licensees were selected as vendors to market assessment services. During 1991-1993, SEI self-assessment training was gradually phased out and replaced by vendor training. Based largely on the success and widespread use of the maturity framework and Software Process Assessments, Version 1.0 of the Capability Maturity Model® for Software (CMM®) was published in 1991 [Paulk 91, Weber 91]. In 1993 the CMM was revised, and Version 1.1 was published. Various organizations modified SPAs to reflect the CMM; however, the CMM-Based Appraisal for Internal Process Improvement (CBA IPI) method is the first CMM-based assessment method released by the SEI. After being field tested in 1994, CBA IPI V1.0 was released in May 1995 and upgraded to CBA IPI V1.1 in March 1996.

Data from assessments are collected by the SEI and provide information on the state of the practice. Updates to the process maturity profile of the software community are published twice a year and are available on the SEI Web site:
<URL: http://www.sei.cmu.edu/sema/profile.html>.

1.2 Overview of the CBA IPI Method

The CBA IPI method is a diagnostic tool that enables an organization to gain insight into its software development capability by identifying strengths and weaknesses of its current processes, to relate these strengths and weaknesses to the CMM, to prioritize software improve-

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ment plans, and to focus on software improvements that are most beneficial, given the organization's current level of maturity and its business goals.

The CBA IPI method is an assessment of an organization's software process capability by a trained group of professionals, led by an SEI-authorized lead assessor, who work as a team to generate findings and ratings relative to the CMM key process areas (KPAs) within the assessment scope. The findings are generated from data collected from questionnaires, document reviews, presentations, and in-depth interviews with middle managers, project leaders, and software practitioners.

The CBA IPI method has two primary goals:

1. Support, enable, and encourage an organization's commitment to software process improvement.
2. Provide an accurate picture of the strengths and weaknesses of the organization's current software process, using the CMM as a reference model, and identify KPAs for improvement.

The approach of the CBA IPI method is to assemble and train a competent assessment team under the leadership of a lead assessor and to conduct a structured series of activities with key people in the organization to understand their problems, concerns, and ideas for improvement. The method is based on the following key assessment principles:

- Use the Capability Maturity Model for Software V1.1 as a process reference model.
- Use a formalized assessment process that complies with the CMM Appraisal Framework (CAF) [Masters 95].
- Involve senior management as the assessment sponsor.
- Base the assessment on the sponsor's business goals and needs.
- Observe strict confidentiality by guaranteeing that no information will be attributed to an individual or project.
- Approach the assessment as a collaborative activity between the assessment team and the organizational participants.

The business needs for process improvement drive the requirements for an assessment. The business needs for process improvement generally include one or more of three closely related factors: reducing costs, improving quality, and decreasing time to market. The fundamental assumption is that the development processes largely determine these factors. More information on the CBA IPI method can be found in [Dunaway 96a].

1.3 Organizational Impacts

There are impacts to an organization that take place as a result of conducting an assessment. This section is a composite of ideas expressed by the authors of this report as well those lead assessors included in the Acknowledgments section.

Specific aspects of the assessment process facilitate "unfreezing" in an organization that is just beginning a process improvement effort and help to provide momentum to organizations that are well underway with a process improvement program. Some key aspects of the assessment process are

- confidentiality rules that help build safety and promote an accurate understanding of the current state of the organization's process
- draft findings presentations that build confidence in the team's work and demonstrate to the organization's staff members that they are being heard
- clear focus on the fact that the findings are within the power of the organization to resolve
- behavior of the assessment team itself, which can and should model and demonstrate high-level maturity behavior

Placing too great an emphasis on the data-gathering and the data-management aspects of assessments, to the neglect of these key interventional aspects, can reduce the chances of appropriate process improvement follow-on action. On the other hand, a proper balance between data handling and organizational intervention increases the chances of appropriate improvement actions.

The nature of an organization's business is an important consideration. Is the organization a research and development center, a DoD contractor, a large software product developer, or a consulting organization? Has the assessment been mandated by a parent organization, or is it the result of an internal initiative?

Other important factors that will affect the assessment include

- the size of the organization being assessed
- whether there are any previous or ongoing quality initiatives
- the amount of CMM training and experience
- how the method is tailored to meet the organization's business goals (The assessment method provides many opportunities for tailoring. How the method is tailored will have an important impact on the process culture.)

1.4 User Feedback

Presentations were given at SEPG '96 [Dunaway 96b] and SEPG '98 [Dunaway 98] to report the feedback that was provided to the SEI regarding the use of the CBA IPI method.

Panelists from previous conferences who shared their experiences and results achieved by use of the CBA IPI method are listed in the Acknowledgments section.

2 Perspectives on Assessments

The following individuals appeared on a panel at SEPG '99 on March 10, 1999, in Atlanta, Georgia, to share their experiences with the audience in the use of the CBA IPI assessment method. They were asked to record their comments in this technical report so that people who were unable to attend the conference could benefit from their experiences.

2.1 Panelist: Ruth Berggren, Electronic Data Systems

2.1.1 Why Do EDS Organizations Conduct Assessments?

To answer this question, it may be helpful first to look briefly at the historical background of process improvement at Electronic Data Systems (EDS).

In 1987 the corporation rolled out a standard methodology called Systems Life Cycle (SLC) and established an expectation that all organizations would use it to deliver products and services to customers. The methodology was supported by education, detailed documentation, and later an assessment and implementation process. By 1993 awareness of the CMM had grown significantly, and EDS adopted the CMM for Software V1.1 as a standard for process improvement and performance for software development and maintenance. By 1996 the first EDS organization achieved the first Level 2 rating (we've had about 35 more since then), and by 1998 we achieved the first Level 3 rating. Most of the CMM-based process improvement initiatives in EDS were predicated by SLC implementations, which helped move the corporate culture toward the use of processes to improve effectiveness and efficiency. EDS currently is experiencing a large increase in the number of assessments each year, as more organizations move forward with process improvement.

The increase in assessments and process improvement initiatives is driven primarily by the customer in the form of

- pressure to achieve higher levels of maturity to keep the business that we have with them or to acquire new or additional business
- extra bidding points awarded for higher levels of maturity for DoD contracts
- requirements for higher levels of maturity to bid as prime contractor for DoD contracts

The bottom line is that most assessments in EDS are performed to provide authentication of our claims of process capability and process maturity. Many EDS organizations initially "pushed" by customer pressure to achieve Level 2 begin to see the benefits and continue the journey.

What benefits are realized?

- Project performance is improved, in terms of fewer defects delivered in the software; this results in more time to spend on providing creative solutions for the customer and reduced cost. Our Level 2 projects also deliver on time more consistently.
- Employee morale improved in most cases because of the involvement of the organization in the assessments. The feedback of assessment findings and subsequent action on those findings leads to more focused improvements.
- Most customers appreciate the improvements in communication and project results.
- Organizations that had successfully implemented the corporate SLC methodology were able to implement the CMM more easily and were generally easier to assess.
- Assessment team members learn the CMM, gain process improvement insight, and carry that knowledge and insight to the process improvement team. These team members are used in other assessments in other corporate divisions. The organization also learns a great deal about the CMM and about itself.

This is not to say that we do not experience some difficulties as well. We occasionally have a sponsor whose objectives for doing the assessment are not closely aligned with the objectives documented in the method. This condition results in institutionalization difficulties as well as difficulties in conducting the assessment due to inadequate site preparation or rushing to get the assessment done before the organization is ready. Other organizations aim too low; they have no strategic decision to attain Level 5. In most organizations, measurement is the most significant institutionalization problem.

2.1.2 Do Assessments Pay Off for EDS?

The answer is a resounding *Yes*! Even when we have difficulties, we learn a great deal from each assessment. These are just a few of the things we have learned:

- Sponsorship is the most critical factor for the success of an assessment and process improvement effort. Get the right sponsor, and cultivate others.
- Organization goals and objectives must be tied to a strategic business plan—without it you can end up in insanity. The business plan usually identifies where the money will be spent. The average direct cost of a CBA IPI assessment is $45,000-50,000.
- All that you hear about change management applies to CMM implementation (education, vision, measurement, etc.). Put your best people on implementation and assessment teams. Send them to SEI classes, the SEI Symposium, and the SEPG Conference.
- Everyone learns (even the ones that are dragged in kicking and screaming). They learn about the organization, the CMM, and about themselves. In most cases it's a positive experience for everyone.
- Assessments help move the organizational culture toward measuring improvement.
- Assessments galvanize the organization to move forward with process improvement.

2.2 Panelist: Gilles des Rochettes, Thomson-CSF

2.2.1 The Thomson-CSF Context

Thomson-CSF is in the business of professional electronic equipment and systems. It is composed of the following eight independent business groups, each of which is composed of business units:

1. Aerospace
2. Avionics
3. Communication
4. Naval Combat Systems
5. Information Systems and Services
6. Optronics
7. Air Traffic Management and Missiles Systems
8. Tubes and Components

The company, when responding to several requests for proposal, had to deal with the requirements in the CMM for Software V1.1 (Level 2 or Level 3) through SCEs or audits by the Federal Aviation Administration (FAA), Ministries of Defence (MoD) (Canada, UK, Australia, etc.), Civil Administration, prime contractors, etc.

While each business group and business unit is independent for creating business, there are many networks called common efficiency teams (CETs) dedicated to the key technical, industrial, and purchase areas (such as software, systems engineering, antennas, signal processing, and microelectronics). Their missions are to share experiences, assets, common developments, studies, resources, and negotiations with suppliers. There is a Software CET, in which the SPICE-Th corporate action (not related to ISO-15504 but to the SEI's CMM for Software) is acting with its sub-network, the Thomson-CSF software process improvement network (SPIN). Within the Software CET, the SPICE-Th corporate action organizes all of the official CBA IPI assessments and mini-assessments to support the business groups' and business units' software engineering process group (SEPG) staffs. For assessments, Thomson-CSF works with two U.S. lead assessors and three internal lead assessors (two others will soon be authorized). There is also a pool of more than 50 CBA IPI assessment team members. This allows Thomson to have not only an assessment program where assessments are done, but also a corporate program that upgrades the team members' knowledge and experience in the CMM, particularly for high-level assessments. Incentives are awarded each year during a one-day celebration, which is another opportunity to share experience and new information. There is an annual rate of 9 official CBA IPI assessments and 15 mini-assessments per year.

A Systems Engineering CET has a pool of 15 assessment team members. Usually, SE-CMM assessments and hardware assessments are conducted using the CBA IPI method led by soft-

ware lead assessors, using some transpositions of the CMM through domain-specific scripts. A policy was issued in 1994 by the chief executive officer (CEO) of Thomson-CSF, requiring that all business units be at Level 3 for software; this provides a strong impetus for all business units. On the systems engineering side, most of the formal CBA IPI assessments are followed with the use of a questionnaire-based assessment, a mini-assessment, or a delta assessment. Thomson-CSF is looking forward to using the Integrated CMM for Software and Systems Engineering (CMMI-SE/SW) and having a model for systems engineering with a recognized status. We will gain leverage from integrated assessments with the software staff who will bring their experience and momentum.

2.2.2 Credibility of the Assessment Team

The key ingredient of a successful assessment is to get consensus from the interviewees on the areas of improvement. Consensus is strongly linked with two elements: (1) the assessment process where interviewees feel that they are being heard, and (2) the credibility of the assessment team so that interviewees trust the accuracy of the findings and agree with how the findings are stated.

What are the risks for the assessment team's credibility? Assessment is a process, so it has to be fully controlled, even when unforeseen events occur. Thanks to our very close collaboration with U.S. lead assessors (we started in 1992), we have defined a standard process for assessments, with quantitative data, tailoring guides, and coverage indicators. First, it is necessary to do quantitative process control of each of the tasks during the on-site period. We now have enough data to permit that control. Maturity model knowledge and experience by the team members is another key issue, and there must be maximum use of professional judgment. The way that questions are raised and the content of the questions are also important factors. The wording of the strengths and weaknesses is important, as well: they must not be too general, and they must be precisely worded, using site terms and acronyms, and quoting as many examples as possible (e.g., site standards, assets, events). In addition, it is important to consider coverage of the CMM, as well as the organization and the life cycle. How much credibility would an assessment team have if they missed some notable weaknesses for a project? At Thomson-CSF, we track the coverage through daily quantitative indicators that allow us to optimize and replan the assessment schedule. We also noticed that the recommendation report was a risk for the assessment team's credibility. This can be a danger if you only turn the weaknesses into the positive form or provide suggestions that do not help. We have chosen to include only the top-10 recommendations in our report, but require that the organization address all of the other weaknesses that were discovered. Obviously it is the lead assessor's responsibility to maintain the assessment team's credibility during the whole assessment process including the follow-on actions.

2.2.3 Key Planning Issues

The efficiency of the interviews is strongly linked to the confidence of the participants. There are always barriers to open discussion for many interviewees, dependent upon their level of

security in the organization, their trust in the assessment team, their fears for the future (e.g., re-organizations, actions for improvement). For example, it is always interesting to analyze why it is sometimes difficult or not natural to identify good practices. Do the interviewees fear that there will be few acknowledgments or incentives for what they create? Do they fear that now their private practices will become compulsory? Do they underestimate their practices? The choice of representatives for the assessed organization is key. It is always a compromise between getting maximum information in a limited time and the risk of "silences" in the interviews. There is also a risk of an SEPG leader or a member of a software quality assurance (SQA) group who has a vested interest in the assessment outcomes. In our assessments (apart from those dealing with "product line approach"), there is usually only one representative from a particular group.

2.2.4 Follow-On Actions

Our first experience, in 1992 and 1993 when we did SPAs, produced a recommendation report more than four months after the assessment that was so thick and confidential that very few people could read and use it. When the CBA IPI method was released in early 1995, we decided to provide a recommendation presentation no later than one month after the assessment. Presently most of the assessed units volunteer for a review of their strategic plan by corporate management and by the most advanced units. Currently two mini-assessments are planned: the first, which is planned about six months after the strategic plan is approved, will provide an initial checkpoint about its implementation and about the key choices; the second, which is planned about six months before the formal assessment, will be performed to confirm the readiness and the date of the assessment. Generally our mini-assessments are done by two people for two days. We can assess approximately six to eight key process areas and read many documents, plus observe some demonstration of the infrastructure. There is also time allowed for a draft finding presentation. For a small organization (generally less than 20 people), which cannot afford the full assessment method, the mini-assessments provide a mechanism to assess the Level 2 key practices and provide a light improvement plan.

2.2.5 On-Site Difficulties

We can share two difficulties that we regularly experience during our assessments.

First, *why* the assessment is requested can be a problem. Does management really intend to improve? When you do an assessment, expectations in the organization are raised, so you are at risk if there are no follow-on actions.

In addition, the comeback will be very difficult. We have units whose objectives are "the gold medal." It is very difficult to change these objectives: at the corporate level, our mission is to say, "You are not yet ready," and there has been very little resistance. Our mission is also to improve their way of approaching and interpreting the CMM, and here we are not always successful.

Second, even if it is not jeopardizing the assessment, it is sometimes difficult to get real confidentiality from the interviewees when assessing a level. Generally lack of confidentiality occurs between interviewees and their managers, usually after the draft findings presentations. We have noticed that this is often the case with the SQA staff, who seem to play the role of "protectors of the organization," as they do when there are audits from the customers or from the Defense Administration. We have not yet been able to determine whether there is a real negative impact on the quality of interviews and on the buy-in by the interviewees.

2.2.6 Responding to the Organization's Business Goals

The real opportunity to respond to the organization's business goals is when you propose the recommendations and complete the final findings report. We try to determine the concerns of the interviewees and the management: What are the priorities regarding the assessed KPA, even those of the lower levels? What are the main problems to solve (e.g., low performance of processes, real-life problems to deal with, specific customers to work with)? Setting priorities in this way will allow the assessment team to provide a top-10 list of recommendations that addresses these concerns both for determining which KPA to improve and for describing how to achieve a higher level of maturity.

For most of our advanced units, a return on investment higher than four has been achieved, even while getting to Level 2. The next step for Thomson-CSF is to do integrated assessments and improvements of the three key disciplines: contract program management, system engineering, and software engineering. We have noticed that there is a risk of a maturity gap between software and the other disciplines. That is why Thomson-CSF is involved in the capability maturity model integration (CMMI) effort and is a candidate for being a pilot using the CMMI-SE/SW.

2.3 Panelist: Paul Iredale, Reuters

2.3.1 Software Process Improvement History at Reuters

At the beginning of 1996, Reuters piloted its first process improvement initiatives in various development groups worldwide based on an approach used by Hewlett Packard. A development group was asked sets of questions to get an understanding of the major problems facing the organization at that time. The results of these questions were presented to the organization as a set of opportunities not unlike the CMM formal assessment currently used (CBA IPI). A process improvement project was then set up to address the most critical problem. It soon became apparent that, by the time the project delivered the process, there were other new, more pressing problems and that the expected benefits of the specific process improvement project had significantly diminished. So in August 1996, a decision was made to employ a standard to guide organizations in the Development Federation in their process improvement activities. The SEI Capability Maturity Model was chosen as the standard. Goals were set for groups to achieve CMM Level 2 by the end of 1998 and CMM Level 3 by the end of 1999. On December 4, 1998, the final group in the Corporate Technology Group (CTG) software process improvement initiative achieved CMM Level 2. The UK Operations Group, which

consists of 68 people in 3 support groups, was told of their achievement 1 year, 1 month, and 17 days after the first CTG Group [Equisoft in Colchester (now CSTG-UK)] achieved their Level 2 rating. The Transactions Product Groups in Hauppauge achieved Level 2 in September 1997, and the Transactions Product Group in London achieved Level 2 in October 1998. In total over 1500 software engineers in 14 locations and 5 countries all are at CMM Level 2. Now the goal is to achieve Level 3 in 1999.

2.3.2 Why Have Assessments?

The CMM offers a framework for continuous process improvement that is deployed in a series of steps, or maturity levels. Each maturity level builds upon the previous level and the organization achieves known operational characteristics as maturity increases. The attraction of this approach is the common framework and language, coupled with the local interpretation needed to align the process with the differing business needs of the development groups. *In simple terms, you can think globally and act locally.* The CMM as a process improvement framework directs the organization by indicating what needs to be done to achieve the maturity levels, and the local organization makes the decision regarding how activities are implemented. This approach allows the common framework to be molded to the local needs of the organization's business.

Assessments raise awareness within groups by mirroring the organization, its strengths, and its weaknesses. Groups take ownership of their problems and plan to resolve them in a logical order that is indicated by the model. Internally proposed improvements are accepted, rather than resisted. An assessment is a logical part of the IDEAL[SM] improvement cycle; it provides the ability to look jointly into the mirror and openly agree on the problems. It also helps maintain a continuous focus on software process improvement (SPI), even in places where sponsorship is light.

2.3.3 Assessment Mix

Performing formal assessments such as CBA IPIs every 12 to 24 months is not sufficient. We also use mini-assessments every quarter and a scoring system that is reported monthly to track SPI progress very closely. This is analogous to major project milestones (quarterly mini-assessments) and regular monitoring of tasks in progress (monthly scores). Major milestones always provide evidence of solid improvement through greater depth or review.

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2.3.4 What Benefits Has Achieving CMM Level 2 Brought to Reuters ?

The most obvious benefits that have come from achieving Level 2 are concerned with management and control of the development projects being run within the group. Management now has a clear view of the cost, effort, and resources required to perform projects within their groups. In addition, the development organizations have started to measure key parameters related to their performance, and these measurements are being used to identify areas where the process can be made more efficient. These benefits are the tangible ones that directly relate to a process being deployed within the groups.

There are other benefits that are more subtle, but of greater importance. Adopting the CMM provides a mechanism for introducing global change into the Reuters development community. As higher maturity levels are reached, corporate goals are used to steer the process improvement activities; this aligns the process and technology with the direction of the corporate business strategy.

2.3.5 How Have the Development Groups Changed as a Result of Their Process Improvement Activities?

There is now a structure of software engineering process groups and councils (SEPGs and SEPCs). The SEPG would typically contain staff representing the main disciplines within the group: architecture, design, coding, test, software quality, project management, and training. Each SEPG has one representative sitting on the area SEPC. This network of process improvement groups has already started to look at some of the common issues of CMM Level 3 by setting up further groups to address issues of importance in an area, and sometimes on a global basis. Some examples of these groups and their activities are

- the Global Testing Association (GTA), which seeks to provide a common testing approach for all groups
- the UK SQA working group
- the North American Training Council (NATC)
- the United Kingdom Training Council (UKTC)

The training councils link with human resources (HR) initiatives in staff development to provide a curriculum, a career map, and a training plan for addressing the skills required for Level 3 activities. Development groups have started to take responsibility for specific areas of the Level 3 initiative, and these groups will be reviewing their ideas with other groups worldwide, with the intention of providing a solution that everyone can use. This focus is now causing groups to communicate with each other on a regular basis on technical and process issues using a common language to describe the process and technology. The individuals involved in these initiatives are motivated to improve their working environment. The CMM initiative has empowered them, and they are beginning to make changes that will have a profound effect on the way that development is performed. The CMM is providing an infra-

structure for groups to communicate with and understand each other, and is giving individuals the opportunity to improve their working practices.

2.4 Panelist: Itzhak Lavi, Israel Aircraft Industries

Israel Aircraft Industries (IAI) is the largest industrial enterprise in Israel. It is composed of 14 divisions, of which 6 are heavily involved in development, production, and maintenance of embedded computer systems.

IAI started to promote corporate-level activities for improving its software development methods in the early 80s, and later (a short time after the publication of the CMM) adopted the CMM as a reference for improving the software processes employed in IAI's divisions.

IAI has performed 12 software assessments from 1992 through the end of 1998. Three of these assessments were "initial assessments," while the other nine were "non-initial assessments." Initial assessments are conducted as a first step in an organization that is just beginning to improve its software process. Non-initial assessments, on the other hand, are conducted mainly to confirm that a pre-defined milestone of achieving of a certain CMM level has been attained. It is possible for non-initial assessments to be the first assessment in an organization, since an organization may start a SPI program without a formal initial assessment.

Israel Aircraft Industries started to perform assessments in 1992, a short time after its SPI program was launched. The first assessments were initially intended to identify major deficiencies (and strengths) in IAI's software processes and to set priorities for corrective actions. However, the main purpose was to get senior management's attention and sponsorship, as well as the wide participation of middle managers and practitioners in the SPI efforts.

The first two assessments conducted in 1992 were Software Process Assessments, and they took place in two different divisions. The results were only partially successful; although they both gave reasonably good results in identifying and prioritizing areas for improvement, only one of these assessments was successful in the getting management's attention and wide buy-in. In fact, in one of the divisions where senior management was skeptical from the beginning, the assessment results did not result in a major change.

Later, when our processes began to improve, we conducted more assessments, most of them CBA IPIs, mainly to verify that the desired CMM level was achieved, but also to identify further deficiencies and to set the framework for further efforts in process improvement.

We found that the high price of formal CBA IPI assessments (both in cost and in disturbance to the assessed organization) does not allow for such assessments to be performed more than once every two to three years in the same division. We also found that assessments performed to verify attainment of a CMM level may not be the best tool for detecting deficiencies in the software process. For this purpose, we use informal process audits. While the CBA IPI

method is well defined and is based on firm principles that guarantee the accuracy of the assessments results, our informal process audits are based mainly on our own experience. We would like to have a more instructive and well-defined method for performing these audits—a method that would be based on wide experience and meticulous analysis of the information that is obtained in the audit and its interpretation.

In general, assessments do pay off when they are performed as an integral part of a SPI effort. An assessment costs around $100,000, including the preparation and team training, but this is only a small fraction of the cost of an ongoing SPI effort. There is not much data on the return on investment (ROI) of SPI efforts. I believe the main reason for this is that it is very difficult to measure the quantitative outcome of such efforts, due to the following reasons:

- Organizations with a low maturity lack a reliable database of measurements.
- Process improvement is a lengthy process. With the quickly changing software development technology, a few years may also mean changes in the software staff, changes in the development environment (hardware, software and network), changes in the methods used (e.g., transfer to object-oriented design, or OOD), and changes in the programming languages used. It is not clear to what extent measured results are the outcome of process improvement efforts, rather than the other changes.

However, at IAI, we have observed some significant improvement in our performance, such as a significant decrease in system-integration time and in the effort required to correct software defects.

In addition, the following *non-quantitative* results of a SPI program have been observed:

- awareness of software management practices
- better understanding of the engineering nature of software development
- institutionalization of software engineering process groups in IAI's divisions
- construction of a general de facto model for process improvement in the enterprise
- increase in marketing capabilities

To summarize, based on IAI's accumulated experience, the following observations and conclusions can be made:

- Initial assessments pay off, provided that senior management is willing to listen and use their results seriously. In this case, they can help in unfreezing organizations. Although CBA IPI assessments provide more accurate results, SPAs can be used as initial assessments, since they are less expensive.
- Initial assessments are not always required. This may be the case when the present process deficiencies and strengths are already known, senior management is already convinced that the software process should be improved, and they are ready to direct the organization to make this effort.
- In other cases, senior management may not really be interested in improving the software process. In such cases, initial assessments may not be sufficient to start a SPI effort.

- Non-initial assessments also pay off when they are performed to verify that a major SPI program milestone (such as "achieve level X by a certain date") has been attained. A CBA IPI assessment usually will produce results that reflect quite accurately the status of an organization's software process. However, they should not be done more frequently than once every two to three years in the same organization since they are rather expensive.
- Using assessments both for level rating (when a certain level is expected) and as a primary tool for identifying deficiencies is risky, as it may lead to less reliable results. Efforts should be made to develop a reliable method for conducting process audits ("mini-assessments") that will identify deficiencies and strengths without attempting to determine the CMM level. Such "mini-assessments" should be much less expensive and should be conducted two to four times a year to provide an ongoing mechanism for setting the proper framework for the SPI efforts.
- While it is difficult to calculate the *quantitative* results (ROI) of a SPI program, there are many significant *non-quantitative* results that can be associated with such an effort.

2.5 Panelist: Guy Taylor, U.S. Navy

At the Naval Surface Warfare Center, Port Hueneme Division, Dam Neck, our involvement in software process improvement began as an SEI affiliate in 1990. Our organizations served as beta test sites for the Maturity Questionnaire in 1992 and have hosted the SEI on several other occasions. Our first exposure to the CMM and assessments occurred in 1992 when a Software Capability Evaluation was performed on our organization as we were competing for a joint tactical software system development project. The evaluation team informed us after the assessment that we had everything needed to be a Level 2 organization except for a quality assurance plan.

At that point, our organization began the journey in process improvement. Our organization obtained CMM training and formed a team to conduct SCEs. A part-time software engineering process group was established, and the team began performing internal assessments in 1994. (Note: We consider an internal assessment as one that is performed by a team where all members are employees of our local detachment, including the lead assessors. An external assessment is one that is performed by a team that is led by and includes members from a commercial contractor.)

In 1995, a team of six people received lead assessor training to facilitate our process improvement efforts. We established a full-time SEPG, built our process asset library, and implemented a key process owner concept. The lead assessors then performed internal assessments using the CBA IPI method. We used that method to verify our Level 2 rating, and we continued performing internal assessments focusing on new projects to determine their Level 2 conformance. Following a major reorganization, another internal assessment was performed to verify that we still complied with Level 2 . Additional internal assessments were performed on selected Level 3 process areas to determine our progress to Level 3 and to continue to ensure that the organization was ready for a formal external assessment for Level 3 in 1997. We received our Level 3 rating from an external assessment in September 1997.

We have found that internal assessments are invaluable at our organization. In 1997, it was determined after our external assessment that we had a 4.1 to 1 return on investment that year. Internal assessments educate new project personnel about the CMM and the assessment method. They motivate change and verify compliance to the CMM on a project-by-project basis. We also found internal assessments to be an effective tool for verifying compliance after reorganizations and readiness for ratings.

3 Question-and-Answer Session

The audience participated in a question-and-answer session following the panelists' presentations. The following questions were asked:

Why conduct a CBA IPI assessment when an organization is already aware of its weaknesses? Why pay the cost of doing a formal CBA IPI assessment—estimated to cost $100,000?

Berggren: Many times the organization does not have a good enough understanding of the CMM to be aware of its weaknesses. The assessment process applies a scientific approach to comparing the existing practices to the CMM and interpreting the CMM in the environment being assessed. Most of our assessments run less than $45,000 (including travel).

Des Rochettes: Members of the internal SEPG cannot be fully unbiased, especially if there is management pressure. We have some examples of organizations that thought they were Level 3 and were assessed at Level 1. Also sometimes the SEPG is more pessimistic than realistic.

Iredale: First of all, we did not find our internal assessments to cost $100,000. We have seven SEI-authorized lead assessors, and they are paid whether they are performing assessments or any other SEPG function within our organization. An assessment is a logical part of the IDEAL improvement cycle; it provides the ability to look jointly into the mirror and openly agree on the problems. It also helps maintain continuous focus on SPI even in places where sponsorship is light.

Lavi: Being aware of the weaknesses is not enough to start correcting them. Organizations that are just starting to improve their process need a public demonstration to start the improvement and buy-in efforts, although other less expensive methods (like SPA) may serve the same purpose. Other organizations need the CBA IPI assessment because it's the only reliable way to determine an organization's CMM level, when achievement of certain CMM levels is defined as a program milestone.

Taylor: First of all, we did not find our internal assessments to cost $100,000. We have six authorized lead assessors, and they are paid whether they are performing assessments or any other SEPG function within our organization. The only additional cost is the time that project personnel are required to be available. That is only for interviews and presentations, which is less than four hours per individual. Weaknesses may be known by some, but they are never as visible as when they turn up in outbriefs.

How often do you do full CBA IPI assessments?

Berggren: In the lower maturity levels, every 12-18 months.

Des Rochettes: Full assessments are done for rating a maturity level. (Some years ago, we did dummy assessments for the full process, but obviously the ROI was low compared with using mini-assessments.) At Thomson-CSF, it takes an average of 30 months for an organization to get to Level 2. After the strategic plan is approved, it takes an average of 22 months for a Level 2 organization to be ready for a Level 3 on-site assessment.

Iredale: Usually once a year.

Lavi: Usually once in two to three years.

Taylor: When we were striving to establish our process improvement effort, we did them more often than after we were Level 2 working towards Level 3. We never did one less than six months after another. Depending on the size of the organization, I recommend an assessment at least every two years.

On how small of an organization is it feasible to perform a CBA IPI assessment?

Berggren: The smallest group I have assessed is 65 people.

Des Rochettes: The smallest organization that had a full assessment had 40 to 50 software practitioners.

Iredale: The smallest group I have assessed is 30 people.

Lavi: In IAI the smallest organization in which we perform CBA IPI assessments has about 35 software engineers. I think a CBA IPI assessment is feasible in an organization that has at least 30 software engineers.

Taylor: I have performed a CBA IPI assessment on an organization as small as 150 people. They thought that it was effective and they are doing quite well in process improvement to date.

How is it possible to maintain consistency among assessments being done internationally?

Berggren: The assessment method and the model provide the consistency. For me it was a little more difficult to get a quick understanding of the development environment in a country where I was not fluent in the language.

Des Rochettes: In our company there is an ongoing mix of interventions (e.g., full assessments, mini-assessments, consulting days, reviews) of our U.S. and internal lead assessors, as well as the team members. All of our internal lead assessors were previously team members for SPAs, then for CBA IPI assessments with our two current U.S. lead assessors. They were trained and coached by the U.S. lead assessors. This means that there is a cross- and auto-benchmarking between the way we all do the job. To date, everything has gone smoothly and coherently, which means that we strongly think that we are standardized with our U.S. lead assessors, who are some of the most active lead assessors. But above all, one should never forget that if the CMM is covered and the CBA IPI method is followed, then the repeatability of the results is ensured.

Iredale: We try to use a core team of seven SEI-authorized lead assessors who have all been trained at Reuters in addition to their SEI training.

Lavi: Basically a CBA IPI assessment is an internal audit, unlike International Organization for Standardization (ISO) 9000 audits where consistency is much more important. Yet, the CBA IPI method is very well defined, and this contributes to the consistency and reliability of the results. In addition we at IAI sometimes call on external lead assessors to participate in our assessments, although we have internal lead assessors, to ensure consistency and reliability of the assessment results.

How is it possible to reduce the impact, stress, and disruption on an organization when an assessment is conducted?

Berggren: The key is planning and preparation. The sponsor needs to communicate to the organization that an assessment is going to be done, the organization's expected behavior, the priority of the assessment, why it is being done, and what will be done with the results. Communicating the priority of the assessment to the organization should help prevent situations where the team is bumped from an interview room or is interrupted during an interview. A good site coordinator is crucial to a smooth-running assessment. He or she must communicate the schedule and logistics to the participants so that they can plan accordingly. The site coordinator needs to be trained in the method as soon as possible to begin performing this role. Participants need to adjust commitments so that they can participate fully. As a lead assessor, I plan my schedule so that I can deliver the participants' briefing to give them an

opportunity to meet me, ask questions, and express concerns they may have before the on-site period.

Des Rochettes: First of all, the full assessment will require no more than seven hours for most people (mainly the software project managers and the SEPG) and an average of less than six hours for the majority of the participants. One of the key features of the CBA IPI method is to make people feel free and comfortable, and our experience is that buy-in is usually obtained. So there may be stress before the assessment, but rarely are people disappointed. The only case of disappointment is when management doesn't follow on or sponsor the improvement actions.

Iredale: The key is planning and preparation. We also use mini-assessments and a scoring system to track SPI progress very closely. There are very few surprises during a formal CBA IPI assessment.

Taylor: I think that it is important to set the context for the assessment early. Let everyone know why the assessment is being done and especially what is expected of them. The sooner everyone understands the assessment process, the better they can prepare. I have found that once they know what is going to happen and how small the impact on them is expected to be, the easier it is to get buy-in from them. Also it is the lead assessor's responsibility to set the tone for the assessment. It should be non-confrontational, and it should be seen as a collaboration between the assessment team and the organization towards a common goal. It is especially important that the participants being interviewed feel comfortable, not intimidated.

If there is one thing that you could change about CBA IPI assessments, what would it be?

Berggren: Late hours—although they are not as late as they used to be.

Des Rochettes: Perhaps work on the means to provide the best recommendations; for example, provide an additional (but optional) framework and method for interviews and queries on concerns and business objectives, and a tracing of findings to actual problems and/or non-performance of processes.

Iredale: Streamline the KPA wall-chart process.

Taylor: No long nights! I thought tagging notes and wall charts were things that could be improved. We developed a tool that helps us automatically tag notes and perform consolidation with an overhead projector. That eliminates the need for wall charts and enables the team to use the same room for interviewing and team work, since we don't need to litter the walls.

How are conflict-of-interest matters handled within an organization during an assessment, such as SEPG members serving as assessment team members who have had a major role in instituting the process improvement activities?

Berggren: The lead assessor should be able to spot hidden agendas on the team regardless of the source, and make sure that the team stays focused on interpreting the CMM in the context of the software development organization being examined. If the conflict cannot be handled through facilitation, the lead assessor also can reassign KPAs—splitting up SEPG members, or assigning them to KPAs not critical to the target maturity level. Although I have never had to do it, the method also allows for assessment team members to be removed from the team. The SEPG members on the team have to abide by the same method as everyone else. The entire team (including the lead assessor) reviews everyone's work and must come to consensus on what they have seen and heard. The consensus process usually works out most of the issues that individual team members may be pursuing at the outset of the assessment. SEPG members usually come away from the assessment talking about how much they learned and are really excited about working on the action plan.

Des Rochettes: We have addressed that in Section 2.2.3 (Key Planning Issues); there is only one representative of the organization; the projects are chosen in a kick-off meeting, with the corporate software director, the lead assessor, and the sponsor and management of the assessed unit. Now when we do Level 3 and higher assessments, the functional area representatives (FARs) are randomly chosen for each FAR sessions.

Iredale: Through consensus of the team.

Lavi: In IAI, SEPG leaders are not allowed to participate as assessment team members in their own division (though they are welcome to participate as team members in other divisions). The same principle holds for other persons who may have direct personal interest in proving their own success or any other possible personal agenda. However, conflicts always exist, and it is the lead assessor's responsibility to identify and resolve such conflicts. Usually the best way to avoid and eliminate such conflicts is by proper selection of team members, proper assessment training, and appropriate leadership.

Taylor: I think the lead assessor should be leery of using SEPG members on the team, especially if they had a major role in the process improvement effort. They do tend to disrupt consensus since they have so much at stake. I have allowed them on some teams depending on their personality and willingness to get accurate results versus a score.

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13. ABSTRACT (MAXIMUM 200 WORDS)

The authors of this report appeared on a panel at SEPG '99 (1999 Software Engineering Process Group Conference) on March 10, 1999, in Atlanta, Georgia. Each panelist is one of the "most active lead assessors" in the Software Engineering Institute (SEI) Appraiser Program and has conducted and reported on over 5 Capability Maturity Model® (CMM®) -Based Appraisals for Internal Process Improvement (CBA IPIs) over the past 18 months. In this report, the panelists document their experiences regarding why an organization chooses to have a CBA IPI and what the organization gains from having conducted an assessment.

Each author discusses the experiences related to CBA IPIs that he or she has led with a focus on the organizational perspective before, during, and after the assessment. Since a CBA IPI is a major organizational intervention, it is important to know why an organization has an assessment, if it has a positive impact on an organization, and how an organization would characterize the benefits that the assessment provides. What needs to be done during the planning, how the assessment is conducted, and what follows the assessment are all important factors that will affect the benefits that the organization experiences from the assessment.

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